Recon Satellite Assumes Dual Role

Launch of spacecraft with both search-and-find and close-look functions marks U.S. move to a new generation of technology

By Philip J. Klass

Washington—U.S. has begun the transition to a new generation of reconnaissance satellites, designed to perform both the search-and-find and close-look functions that previously required the use of two separate spacecraft.

The first of the new-generation satellites, built by Lockheed Missile & Space Co., was launched on June 15 into a near-polar, low-altitude orbit from the Western Test Range (AW&ST June 21, p. 15). The new design is understood to have performed well.

The satellite, unofficially referred to as "Big Bird," weighs approximately 25,000 lb., which is four to five times the weight of present operational designs. The spacecraft, a modified Lockheed Agena measuring approximately 10 ft. in diameter and nearly 50 ft. long, was launched by a USAF/Martin Marietta Titan 3D. It was the first time this large booster with its two large strap-on solid rockets has been used.

Big Bird carries a huge new camera, developed by Perkin-Elmer Corp., which is expected to provide ground resolutions of better than 1 ft. from an orbital altitude just over 100 mi.

Since the U.S. initiated its reconnaissance satellite program in the early 1960s, it has employed two functionally different types of spacecraft, both built by Lockheed using the Agena:

- Search-and-find satellite, for large-area surveillance of the Soviet Union and Red China, to detect new construction facilities of strategic interest. Photos are taken by a camera with a moderate-resolution lens, built by Eastman Kodak Co., and the film is developed on board. Later, when the satellite comes within range of one of seven ground stations situated around the globe, the processed film is scanned by a laser-beam device, produced by CBS Laboratories, to convert the image to an electrical signal which is transmitted to the earth station.
- Close-look satellite, for more detailed examination of newly discovered objects of interest uncovered by the search-and-find type satellite, or already catalogued facilities. This type of satellite usually is outfitted with a high-resolution camera or multi-spectral cameras. After approximately two weeks in orbit, the exposed film, which has fed into the spacecraft's nose capsule, is returned to earth and recovered by Lockheed C-130 aircraft equipped with trapeze-like cables that loop over the capsule's parachute. This is a technique first developed in the USAF/Lockheed Discoverer series.

The current generation of search-and-find reconnaissance satellites is launched [illegible] USAF/McDonnell Douglas Long-Tank-Thrust-Augmented-Thor (LTTAT). Typically the satellite has an initial perigee of about 100 mi. and remains in orbit for three to four weeks.

The close-look type of reconnaissance satellite, slightly heavier than the other type, is launched by a USAF/Martin Marietta Titan 3B. The spacecraft perigee usually is only approximately 80 mi., to maximize ground resolution. The Agena engine, built by Bell Aerospace, is used periodically to boost altitude to provide an orbital lifetime of approximately two weeks.

The U.S. has been gradually reducing the number of reconnaissance satellites of both types which it orbits each year—an indication of the ability of both to carry more film than in the mid-1960s. Whereas the U.S. orbited a total of 13 of the search-and-find spacecraft in 1965, the number declined to only four last year. Similarly, the number of recoverable satellites had dropped to only five in 1970, although the total days in orbit were nearly as many as the U.S. obtained in 1968 by using eight satellites.

Soviet Advance

The Soviet Union also has introduced an improved, longer-lived version of its recoverable reconnaissance satellite. Until the summer of 1968, all of the Russian recoverable satellites remained in orbit for eight days or less.

Cosmos 228, launched on June 21, 1968, was the first to stay aloft for 12 days. Gradually the Soviets began to launch more of the longer-duration spacecraft.

In 1970, nearly half of the 29 recoverable satellites launched by the USSR remained aloft for 12-13 days. During the first six months of 1971, all of the Soviet recoverable satellites remained in orbit for 12-14 days.

The longer-duration satellites enabled the USSR to begin to cut back on the total number of recoverable reconnaissance satellite launches, beginning in 1970. Judging from Soviet launches during the first half of 1971, the total will decline again this year [illegible]

Normally, the two types of satellites are launched alternately, allowing sufficient time for photo analysis at the National Photographic Interpretation Center in Washington to study the pictures from the search-and-find spacecraft before selecting targets for the next close-look satellite mission.

The complementary operation of the two types of reconnaissance satellites is illustrated by the time of official and unofficial disclosures on the new types of Soviet missile silos discovered early this year:

- Nov. 18, 1970: U.S. radio transmission-type reconnaissance satellite launched, which remained in orbit until Dec. 11.
- Feb. 9, 1971: Film-pack returned from recoverable type satellite launched on Jan. 21.
- Mar. 4, 1971: Intelligence officials testifying before the Senate Armed Services Committee disclosed the discovery of the new type Soviet silos. At that time, the number of new silos discovered by satellite photos was about 10.
- Mar. 24, 1971: U.S. launches new radio-reconnaissance satellite to search for additional silos of the new type. Satellite remained in orbit until Apr. 12.
- Apr. 23, 1971: Defense Secretary Melvin Laird disclosed the U.S. had discovered approximately 40 of the new type Soviet missile silos.
- Apr. 27, 1971: Laird disclosed that USSR had resumed construction of its anti-ballistic missile (ABM) system near Moscow, after a three-year lull.
- May 13, 1971: Film pack capsule returned from recoverable close-look satellite launched Apr. 22.
- May 26, 1971: Defense Dept. officials disclosed that 60 of the new Soviet silos had now been discovered. They revealed that the new silos had first been discovered in December, 1970—which would be several weeks after the launch of the search-and-find satellite on Nov. 18. Further, that the diameter of the holes had originally been estimated at slightly less than 30 ft. But within recent weeks, the Pentagon officials disclosed, it had been discovered that there were two slightly different size silos, whose inner diameters differed by approximately 4 ft. Of the 60 new type silos, about one-third were at SS-9 missile bases and the remainder at SS-11 sites.
- Aug. 7, 1971: Pentagon officials disclosed that the Soviets now have nearly 80 of the new type silos.
- Aug. 12, 1971: U.S. launches new

close-look recoverable satellite. Film pack expected to be returned i... te August.

The inherent delay involved between the receipt and analysis of radio transmission type satellite photos and the launch of a close-look type with subsequent recovery of its film pack provides a clue to the design objectives behind the new Lockheed Big Bird.

If a single satellite could be used for both functions, this could greatly speed up the process of obtaining high-resolution photos of newly discovered objects of interest.

This was one of the potential advantages of the Manned Orbiting Laboratory (MOL) which generated support for the program in the mid-1960s. If the MOL astronauts could perform the search-and-find mission, using suitable telescopes, when an object of interest was discovered it could be photographed instantly using a high-resolution camera. The films could then be returned to earth promptly using one of several ejectable capsules carried on board. The MOL also was expected to perform early warning and electromagnetic reconnaissance missions.

At the time the MOL was approved for industry studies on Jan. 23, 1965, the Pentagon emphasized that it was continuing its efforts in unmanned reconnaissance satellite technology.

When the MOL program was killed in June, 1969, the Pentagon explained the decision was the result of rising costs of the project and the Vietnam war. But it is clear that the Nixon Administration would not have dropped the MOL unless there had been encouraging progress in the development of Big Bird which would give it capabilities approaching those expected from MOL.

One disclosure of such progress can be found in the recent Fairchild Industries reply-comments filed with the Federal Communications Commission on July 12, 1971, for the domestic satellite case. Fairchild's proposed satellite would use a 30-ft. dia. unfurlable antenna, similar to one planned for use on the ATS F the company is building for the National Aeronautics and Space Administration. The antenna will be supplied by Lockheed Missile & Space Co., which produces Big Bird.

One of the limitations on the existing search-and-find satellites is the number of photos which can be transmitted down during the spacecraft's pass over a ground station. At low orbital altitude, the satellite remains within range for only 10 min.

One way to increase the number of photos that can be transmitted per pass is to use a larger antenna on the satellite. The number of photos would be increased by approximately the square (second-power) of the antenna diameter. This would explain why Lockheed has gone to the expense and trouble of developing a large, unfurlable antenna.

Fairchild's competitors have criticized its proposal on the grounds that its 30-ft. unfurlable antenna has never been tested in space. Fairchild's recent filing with the FCC contains a copy of an internal Lockheed test report, dated Nov. 21, 1969, which discusses measurements made on a 20-ft. dia. unfurlable antenna "after 20 days exposure in orbit." The date of the tests is not given. But another Lockheed internal document dated June 26, 1968, contained in the Fairchild filing, prompts speculation that two orbital tests had been made by that date.

If the new Big Bird employs a 20-ft. unfurlable antenna, which seems likely, it should be able to transmit approximately 16 times as many photos per pass over a ground station as the existing search-and-find satellites which are understood to use a 5-ft. dia. unfurlable antenna.

From any one of the seven ground stations around the globe, the recorded signals can be re-transmitted to stations near Washington, via the Defense Dept.'s own communications satellites. The use of communications satellites to speed the delivery of search-and-find photos was first introduced in 1967.

Upon receipt of these search-and-find photos at the National Photographic Interpretation Center, they will be rapidly analyzed to discover new objects of interest so that commands can be sent to Big Bird to photograph the area of interest with its high-resolution camera when it later passes over the same object.

These high-resolution photos are expected to be returned periodically by means of ejectable capsules. Because Big Bird is designed to remain in orbit for at least two months, perhaps longer, the spacecraft probably will carry at least several ejectable film capsules.

To achieve an orbital lifetime of several months, Big Bird requires a somewhat higher perigee than the existing close-look satellites. This in turn would result in a loss of resolution were it not for the new Perkin-Elmer camera, with a focal length of more than 8 ft.

Initial orbital parameters for the first Big Bird launched on June 15 include: ... 180-mi. apogee, 96.3-deg. inclination and period of 89.1 min.

Navy Plans Ocean Surveillance Satellite

Washington—Navy hopes to begin development of an ocean surveillance satellite system with Fiscal 1972 funds, using an adaptation the USAF/Lockheed Agena reconnaissance spacecraft. The program bears the code number 749.

The new Navy space system is intended to monitor the movements of the Soviet surface fleet and, if possible, the growing number of Soviet missile-launching submarines. The satellite is expected to be outfitted with an infrared scanner, operating in the 8-14 micron band, and probably a phased-array radar to give it an all-weather capability.

Navy has requested $49.1 million in Fiscal 1972 for space programs, compared to $28.5 million last year. Some of these funds will be used to develop an ultra-high-frequency communications satellite system, known as Fleet-Sat-Com (AW&ST Aug. 23, p. 54), as well as for the 749 surveillance satellite system.

For Fiscal 1972, program 749 has two major elements:

- One, designated W-4418 by the Navy, includes a requirements analysis, configuration definition and the start of system hardware development.
- The other, designated W-4415, is system baseline definition plus development of sensor technology.

ATS 3 Overheated

Applications Technology Satellite 3 in a 23,300-mi. synchronous orbit above Colombia is suffering, literally, from a bad case of summer heat stroke.

The National Aeronautics and Space Administration said the malady has caused the satellite, launched in November, 1967, to stop sending to earth weather pictures and other data.

The problem is believed to lie within an antenna control system which, under normal circumstances, causes an antenna atop the spacecraft to spin about 100 rpm. With the sun in the Northern Hemisphere, the rays bearing directly on the antenna have caused the control system to overheat.

First afflicted in mid-July, the control system began to slow the antenna to 80 rpm., then 50 rpm., and earlier this month the spin rate finally dropped to zero.

But, like people who recover when they stay out of the sun, the 500-lb. ATS is expected to resume normal operations this winter, when the sun moves into the Southern Hemisphere, hitting the antenna at a different angle, and the control system has a chance to cool down.